



Armed Forces College of Medicine AFCM



Histological structure of stomach

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INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture the student will be able to:

1. Describe the structure of the fundus and pylorus.
2. Enumerate cells lining fundic and pyloric glands.
3. Describe the LM and EM structure and correlated functions of the cells lining the fundic and pyloric glands.
4. Correlate the structure of fundus of stomach to its function.
5. Describe the altered microscopic structure of the fundus of stomach in different diseases.
6. Compare between the structure of fundus and pylorus of stomach.
7. Describe the protective mechanisms of gastric mucosa.
8. Describe the epithelial cell renewal in gastric mucosa.



Key points off this lecture



1. Unique microscopic structure of the 4 layers of fundus and pylorus.
2. The fundic gland as a simple branched tubular gland.
3. Structure of the six cells lining fundic and pyloric glands in relation to their functions.
4. Cells contributing to the occurrence of for gastric ulcers, carcinoids and pernicious anemia.
5. Structural differences between fundus & pylorus.
6. Mucous & division as a protective mechanisms of gastric mucosa.
7. Cells responsible for the epithelial cell renewal in gastric mucosa.
8. Rate of cell renewal in stomach epithelium.

Remember these cells' characteristics



Stem cells

•**LM:** Basophilic cytoplasm, vesicular nucleus.

•**EM:**-Abundant ribosomes

- Little Golgi, mitoch, rER

Mucous secreting cell

- Basal basophilia
- Apical pale basophilic foamy cytoplasm full of mucinogen granules

(**PAS positive**).

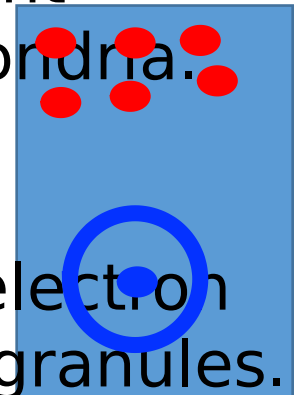
- free Vesicular nucleus.
- Small basal rER
- Supranuclear Golgi.

- Mitochondria
- Apical electron dense granules



Protein secreting cell

- Deep basal basophilia.
- Apical acidophilic zymogen granules.
- Basal vesicular nucleus.
- Well developed basal rER
- □ Supranuclear Golgi
- Abundant mitochondria.



- Apical electron dense granules.

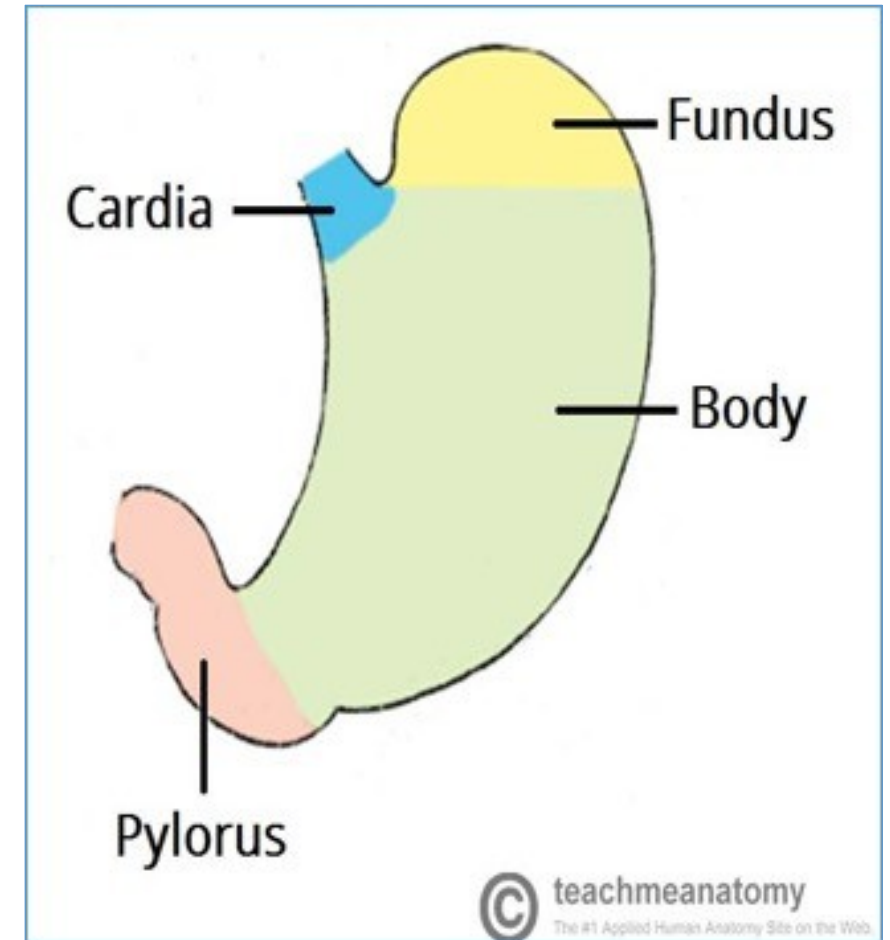


Stomach



The stomach is divided into:

- 1. Cardia:** near the esophageal orifice, contains the cardiac glands.
- 2. Fundus:** the anatomical fundus + body, contain the fundic (gastric) glands.
- 3. Pylorus:** proximal to the pyloric sphincter and contain pyloric glands.



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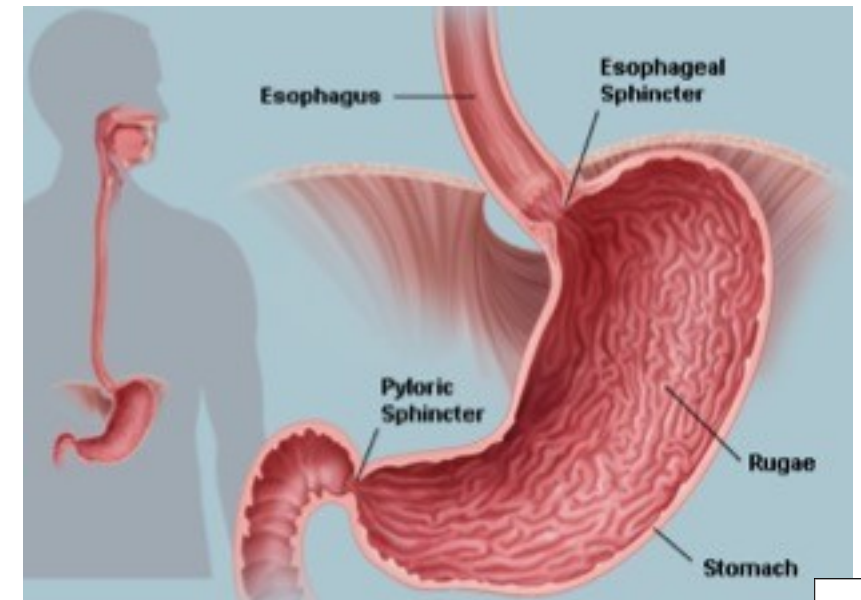
Structure of the Fundus of Stomach



The mucosa of the stomach appears greyish pink in color, thrown into folds called **rugae** (mucosal and submucosal branching longitudinal folds)

These rugae help in expansion of the stomach in different directions to act as a reservoir of food.

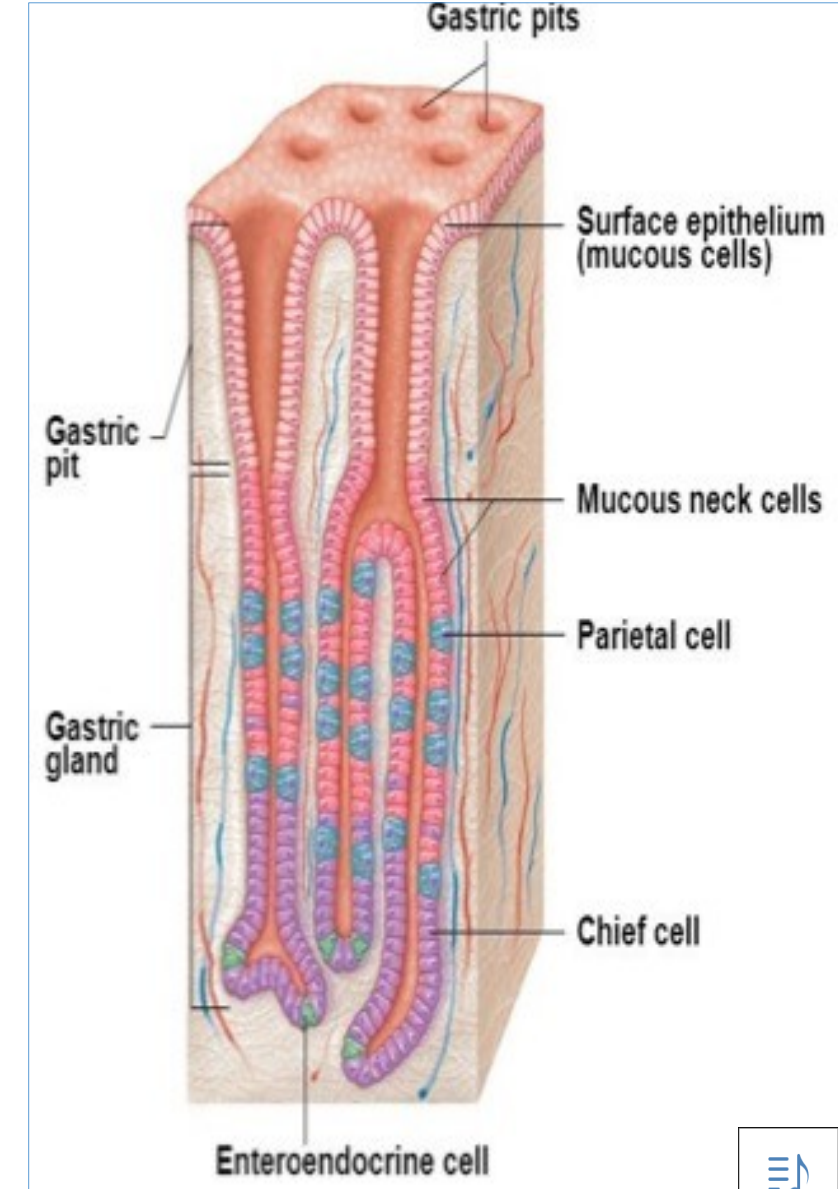
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Structure of the Fundus of Stomach

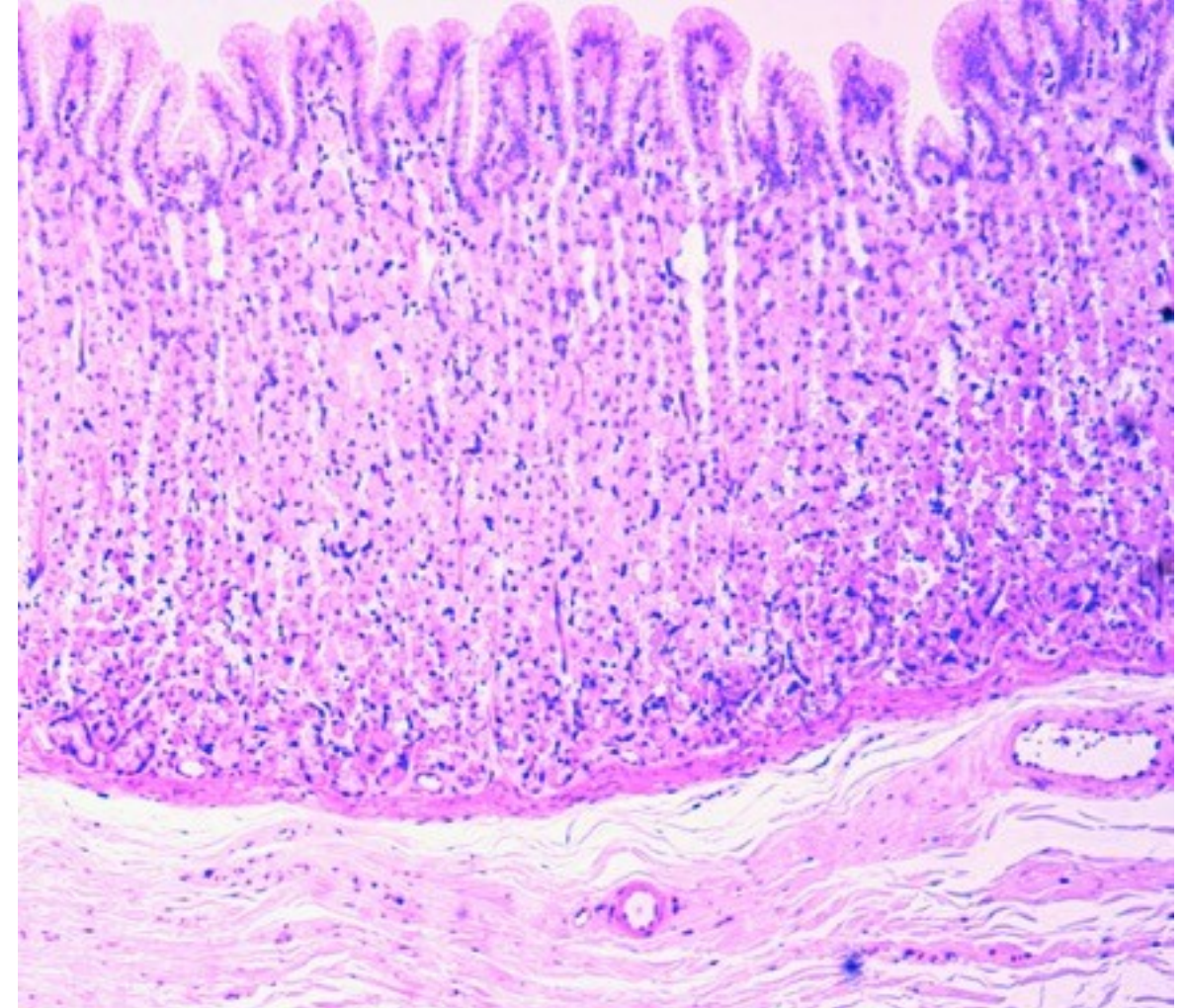


- The gastric epithelium is invaginated deeply into the lamina propria to form **gastric pits (foveolae)**.
- From the bottom of pits several gastric glands extend downward, occupying the greater part of the thickness of the mucosa.



Microscopic structure of fundus: I- Mucosa:

- **The gastric mucosa is formed of:**
 - Surface mucous secreting epithelium (*next slide*).
 - Lamina propria containing **simple tubular fundic glands**
- Muscularis mucosa: 1/4 of the thickness of the mucosa.

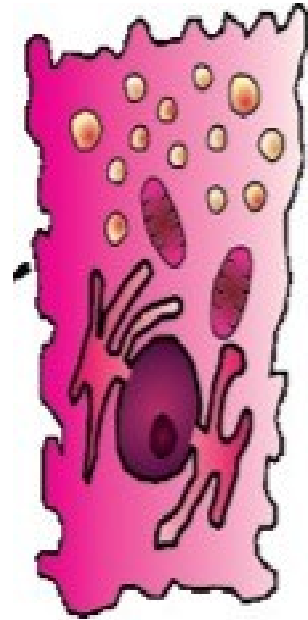




mucous secreting epithelium: Simple columnar epithel

Site: Lines the surface and gastric pits

- **LM** Nucleus: basal oval,
: Cytoplasm: pale basophilic, apical PAS positive mucinogen granules
- **EM:** Small rER, Golgi apparatus, mitochondria, apical electron dense secretory granules.



2Fonline.medunigraz.

Secrete thick, adherent, highly viscous, visible mucous, have cloudy appearance, **rich in bicarbonates** (highly alkaline mucous) forms a gel coat to **protect** mucosa from HCL & rough intraluminal food.



Structure of the Fundus of Stomach

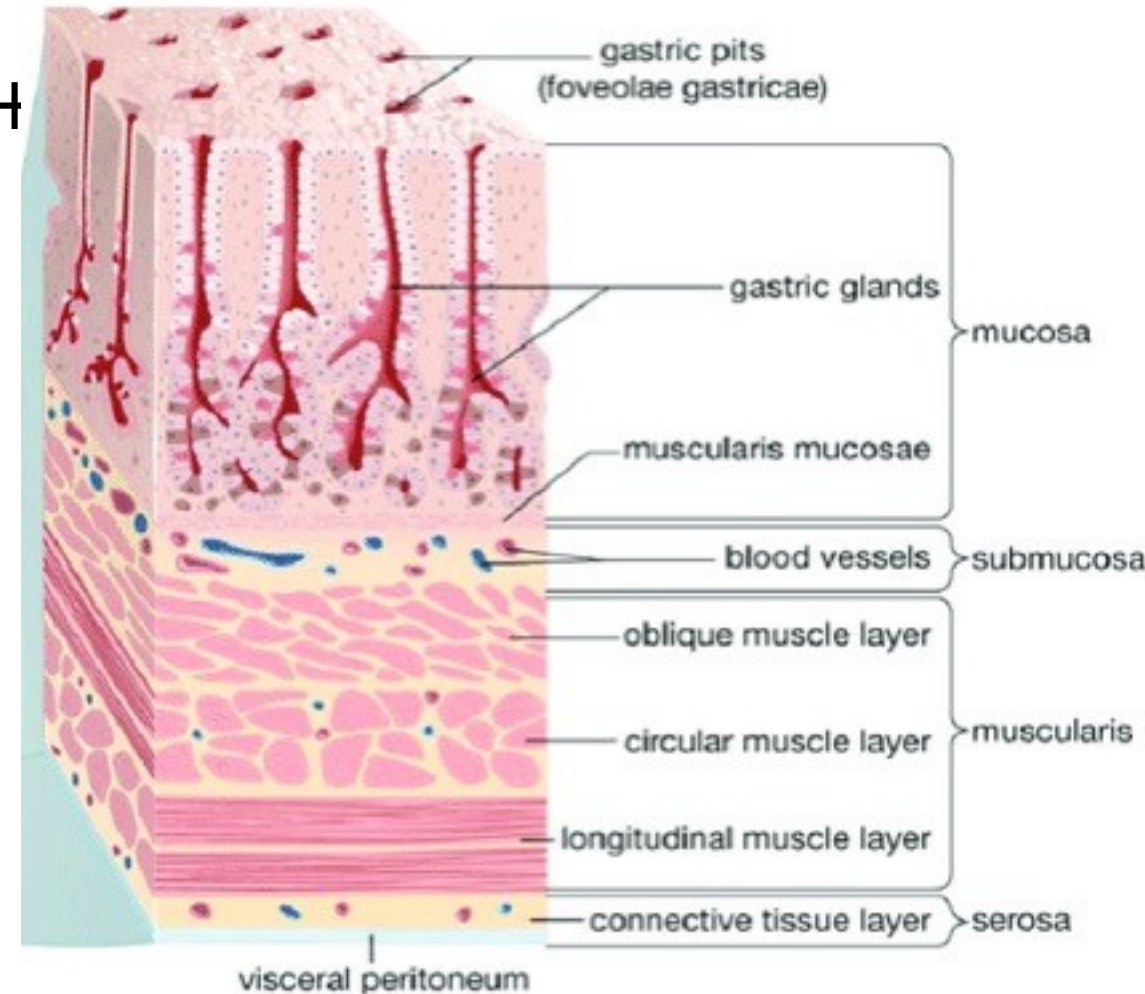


I- Submucosa: c.t. with small b.v. + Meissner's plexus

III- Muscularis externa: (3 layers)

- Innermost **oblique** smooth ms
 - Middle circular smooth ms.
 - Outer longitudinal smooth ms.
- + Auerbach's plexus of nerves.

IV- Serosa



Lecture quiz



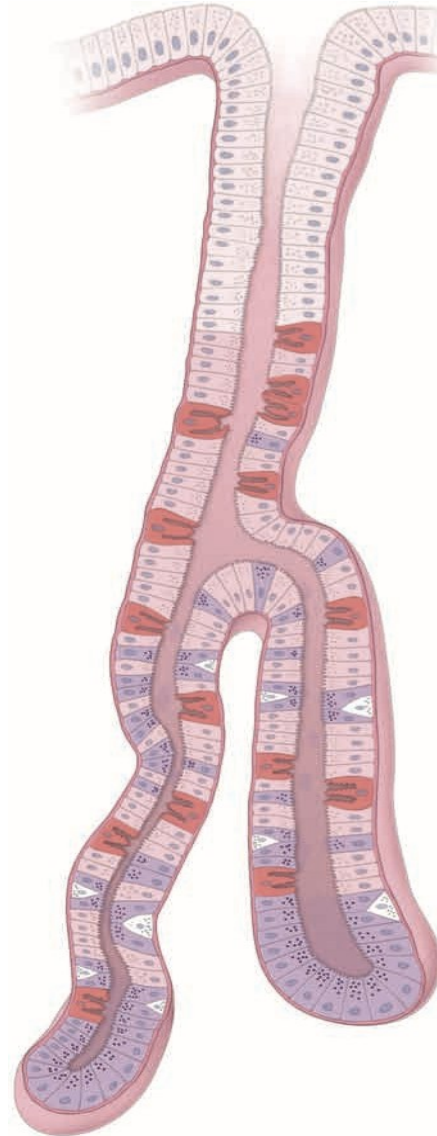
A 65-year-old man presented to the clinic by constant diarrhea not responding to drug treatment for 2 months. The doctor requested to perform an endoscopic examination and biopsy of the stomach. Which of the following would be normally present in the stomach microstructure ?

- a) Few gastric foveolae
- b) Two-layered muscularis externa.
- c) Compound tubular mucosal glands.
- d) Rugae formed of mucosa and submucosa.

Fundic (gastric) glands



- Simple branched tubular
- Narrow lumen.
- Perpendicular to the surface & open to the surface by gastric pits (ducts).
- Each gastric gland is divided into 3 regions: Isthmus, neck & base.



Isthmus

- Surface mucous secreting cells.
- Stem cells.
- **Parietal cells.**
- Enteroendocrine cells.

Neck

- Mucous neck cells.
- Stem cells.
- **Parietal cells.**
- Enteroendocrine cells.

Base

- **Chief cells.**
- **Parietal cells.**
- Enteroendocrine cells.

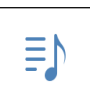


Cells of Fundic (gastric) glands



1- Stem cells

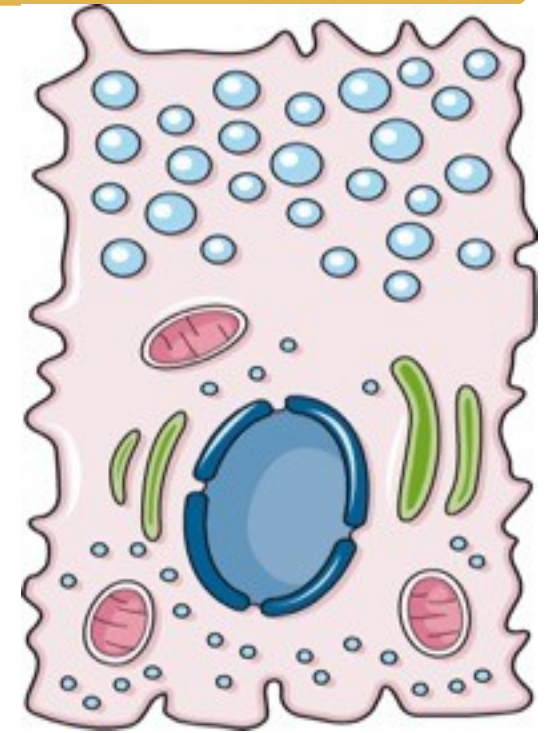
- Site:** isthmus (stem cell niche).
- LM:** basophilic cytoplasm.
- EM:** abundant free ribosomes, little Golgi, little mitochondria,
.....
- Have a high rate of mitosis----- renewal and repair of the epithelium of gastric mucosa.



2- Mucous neck cells



- Site:** Neck region of fundic gland.
- LM:** Apical pale basophilic cytoplasm containing foamy mucinogen granules (**PAS positive**). *(less than surface mucous cells).*
- EM:** - Basal rER, Golgi apparatus, mitochondria.
- Apical electron dense secretory vesicles.



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•Secrete **soluble mucous, less alkaline** than the surface mucous secreting cells to intermingle with the stomach content.

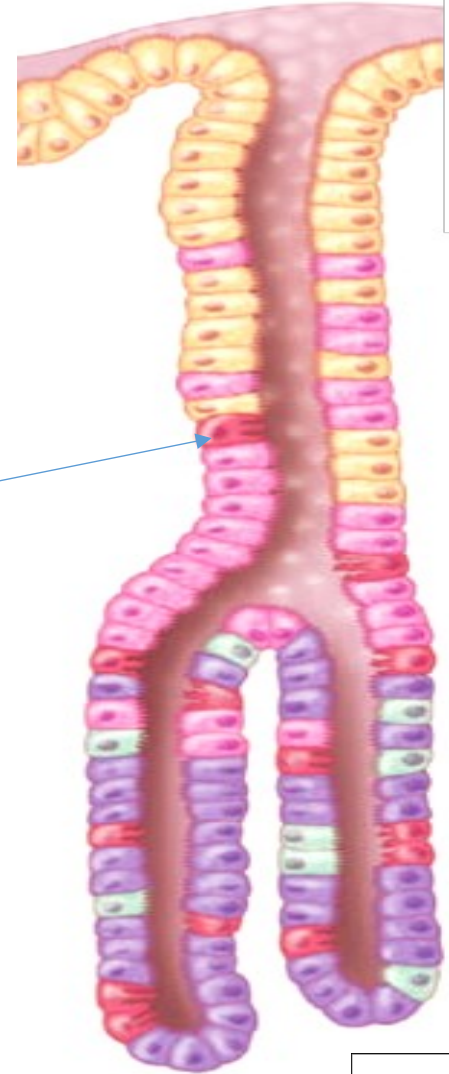


3-Parietal (Oxyntic) cells



Site: All over the gastric glands (mainly in neck), fewer in the base.

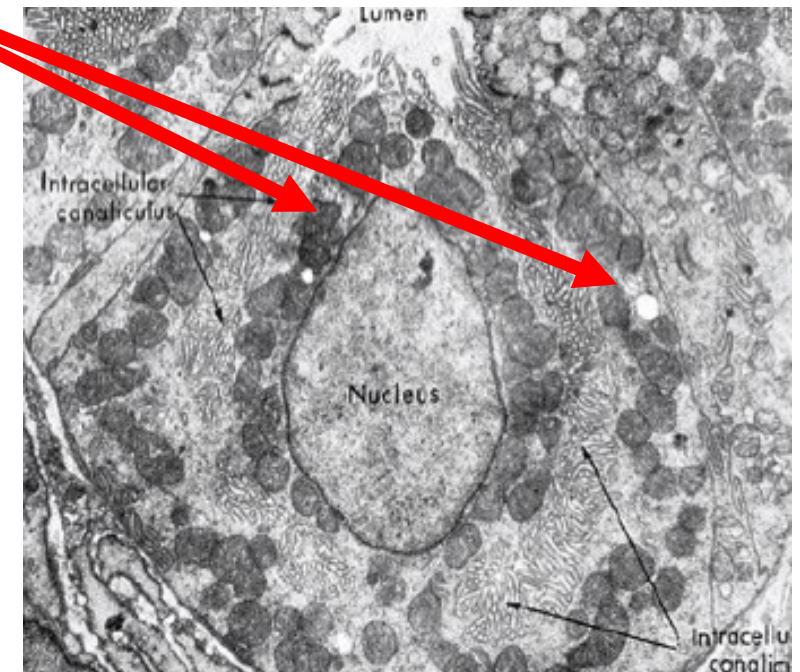
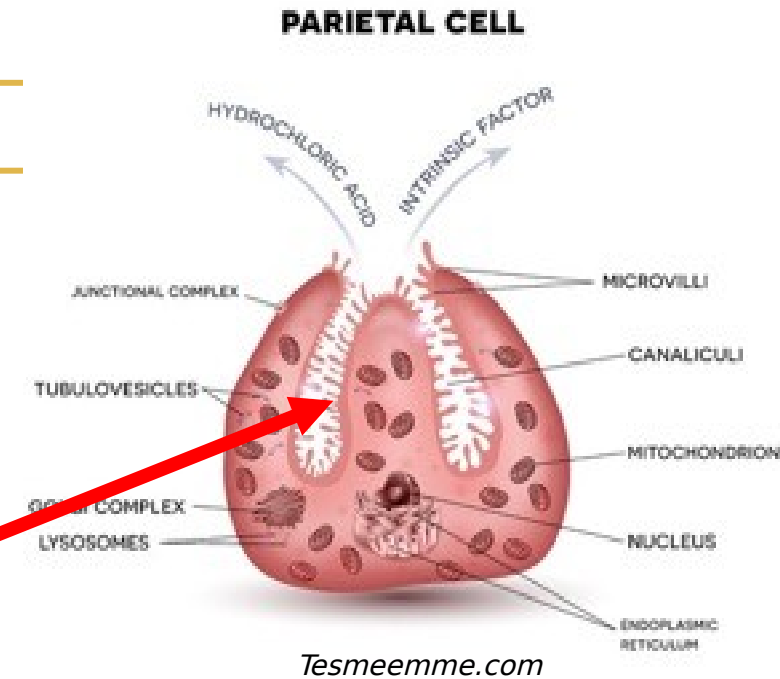
- LM:**
- Rounded or pyramidal.
 - **Deeply acidophilic**
 - Nucleus: rounded central vesicular, may be binucleated



Parietal cells

EM:

- **Abundant mitochondria** (giving the **acidophilia** in LM).
 - **Intracellular canaliculi:** deep invagination of the apical plasma membrane that shows **microvilli**.
 - **Tubulovesicular system** surrounding the canaliculi, acting as a reservoir.
- Little RER, small Golgi complex.

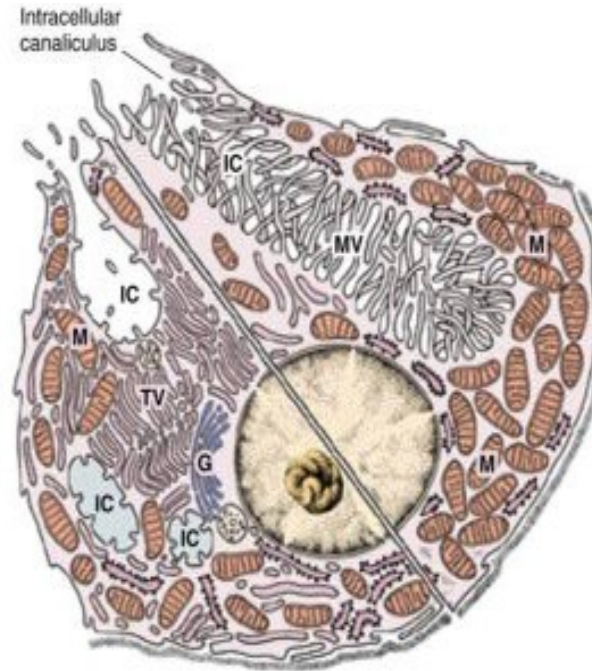


Types of Parietal Cells

Resting

Active

- 1- Short intracellular canaliculi
- 2- less & short microvilli.
- 3- Plenty of tubulovesicles.



- 1- Long wide intracellular canaliculi.
- 2- prominent & increased microvilli.

Junqueira's Basic Histology; Text and Atlas. 12th edition 2016

3- Decreased tubulovesicles. **Tubular vesicles fuse** with the plasma membrane to form a more **elongated intracellular canaliculi (helped by actin)** with **more microvilli**, thus giving $\square$ **increased surface** of the plasma membrane for **HCL & intrinsic factor secretion**

Clinical application: Pernicious anemia



It is a type of anemia caused by damage to parietal cells secondary to atrophic gastritis or auto immune disease.



secretion of insufficient quantities of intrinsic factor
inadequate absorption of **vitamin B12** → Impaired DNA
synthesis → Decrease proliferation of erythroblasts
decreased RBCs formation



Lecture Quiz



A patient presented to the clinic with heartburn which is not relieved by over-the-counter antacids. The doctor prescribed him a proton pump inhibitor for 6 months. This drug is expected to inhibit secretion of which of the following cells?

- a) Parietal cells
- b) Chief cells
- c) Stem cells
- d) Mucous neck cells
- e) Enteroendocrine cells

Lecture quiz



Which is the characteristic finding of active parietal cells upon examination by the TEM?

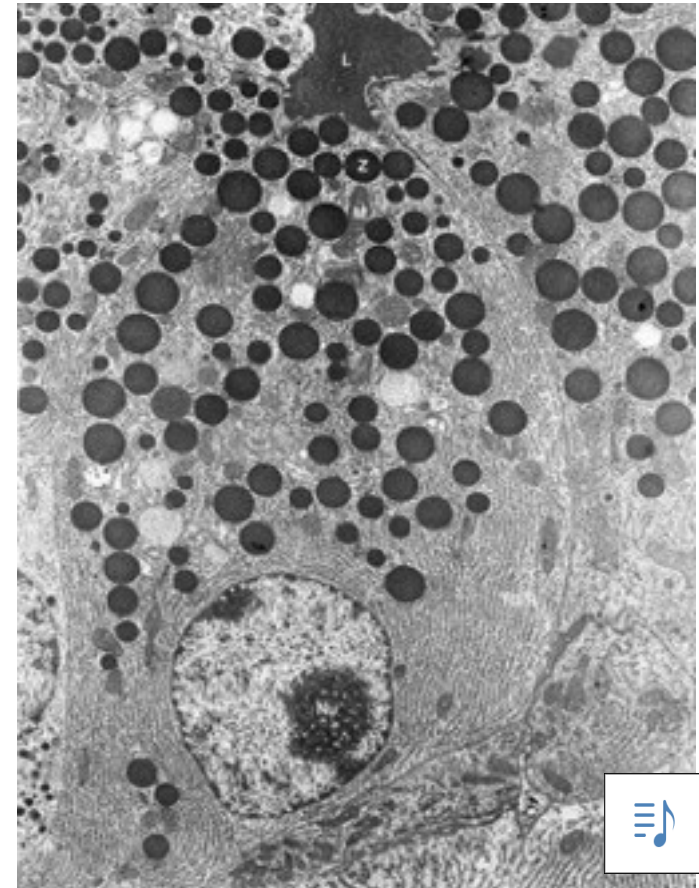
- a) Numerous sER
- b) Numerous rER
- c) Little Golgi complex
- d) Numerous tubulovesicles
- e) Increased intracellular canaliculi

4- Chief (zymogenic) cells



- **Site:** Base of fundic gland
- Cytoplasm: basal deep basophilia, apical acidophilic
- **LM:** zymogen granules
 - Nucleus: rounded, basal, vesicular
- **EM**
 - Apical electron dense granules
 - Extensive supranuclear Golgi
 - Abundant basal rER
 - Abundant mitochondria
- secrete **pepsinogen** (*becomes activated by acidity of stomach into **pepsin***), and **lipase** enzyme.

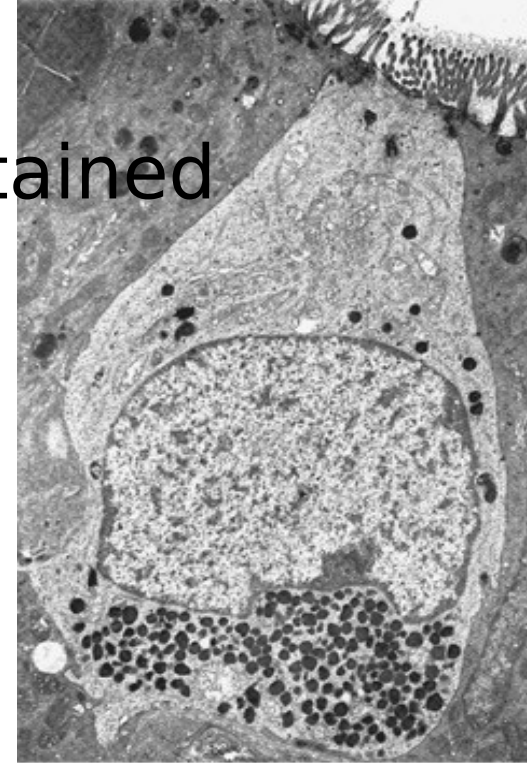
Protein
secretory
cells



5- Enteroendocrine cells



- **Site:** Scattered.
- **By LM:** Not well distinguished by H&E, may be stained with silver (argentaffin cells) or chromium (enterochromaffin cells), or seen best by immunohistochemistry.
- **BY TEM: 2 types:**
 - Open type:** reach the lumen and have apical microvilli (chemoreceptors).
 - Closed type:** do not reach the lumen.
- Both have basal secretory granules.
- Have different names (EC cells, ECL cells,) according to the secreted hormones, affecting the gut motility, secretion of HCL, proliferation of stem cells,



Source: Anthony L. Mescher: Junqueira's Basic Histology: Text and Atlas, 15th Edition. Copyright © McGraw-Hill Education. All rights reserved.



They are tumors arising from **enteroendocrine EC cells**.



Overproduction of serotonin.



Increases gut motility
&
Mucosal vasoconstriction and tissue damage.





Granules of the enteroendocrine cells are characterized by which of the following?

- a) They are PAS positive
- b) Basophilic and apical
- c) They stain negatively with silver
- d) They are situated basally in the cells
- e) They are distributed all over the cell

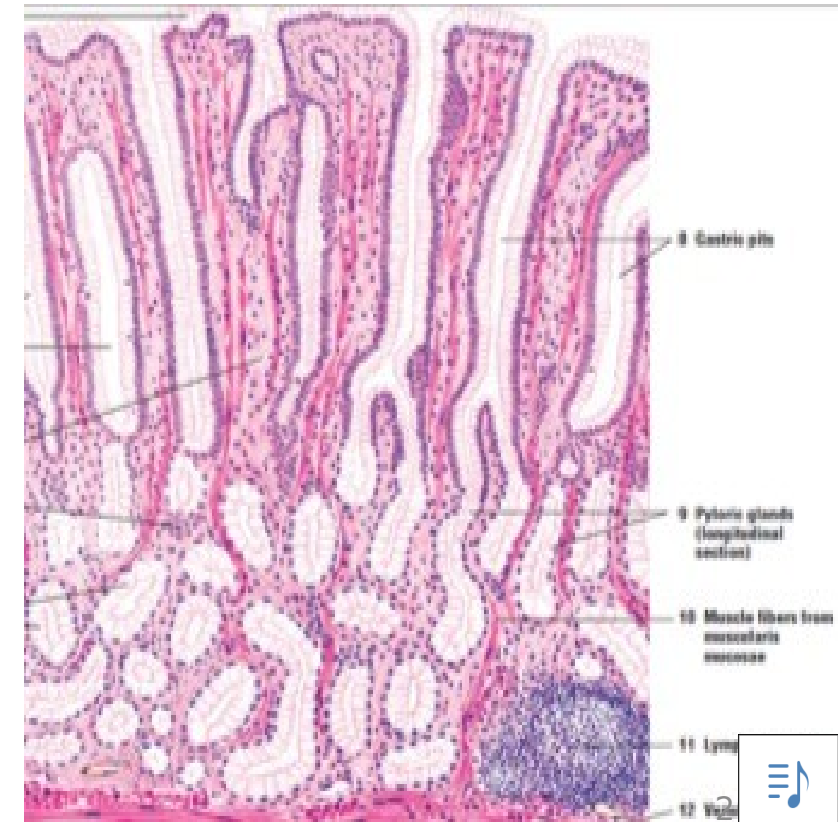
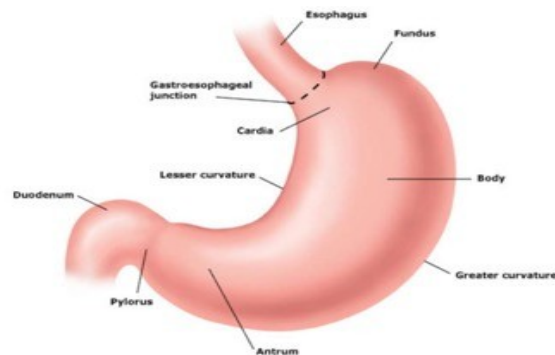
Structure of the Pylorus



Mucosa: thinner than that of the fundus, consists of :
Simple columnar mucous secreting epithelium (cell lines the pits).

lamina propria containing the pyloric glands

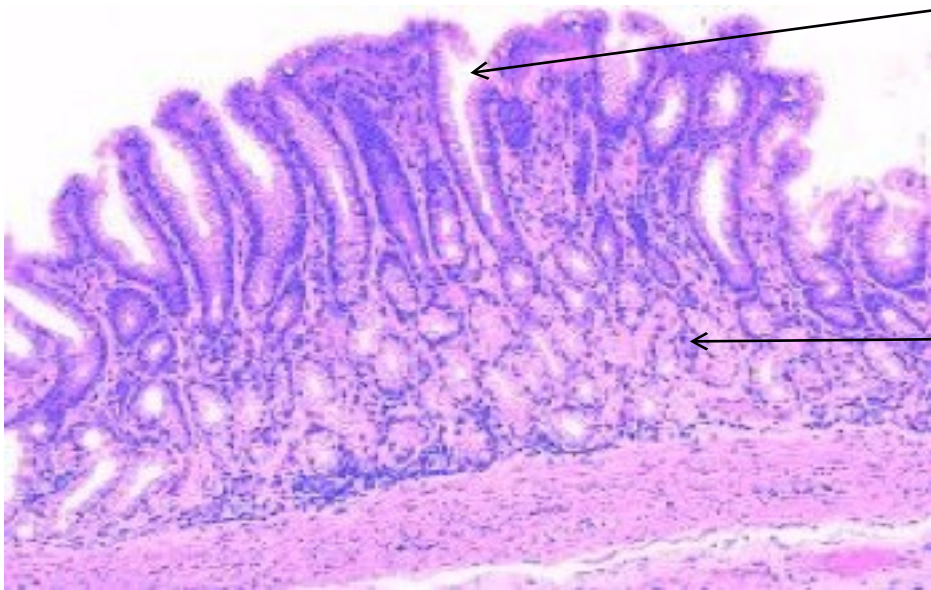
muscularis mucosa: as fundus; IC and OL



Structure of Pylorus



The pyloric glands are **simple branched coiled tubular** glands that are widely separated from each other.



medcell.med.

Gastric pit:

- **wide** and **deep**, taking $\frac{1}{2}$ the thickness of the mucosa

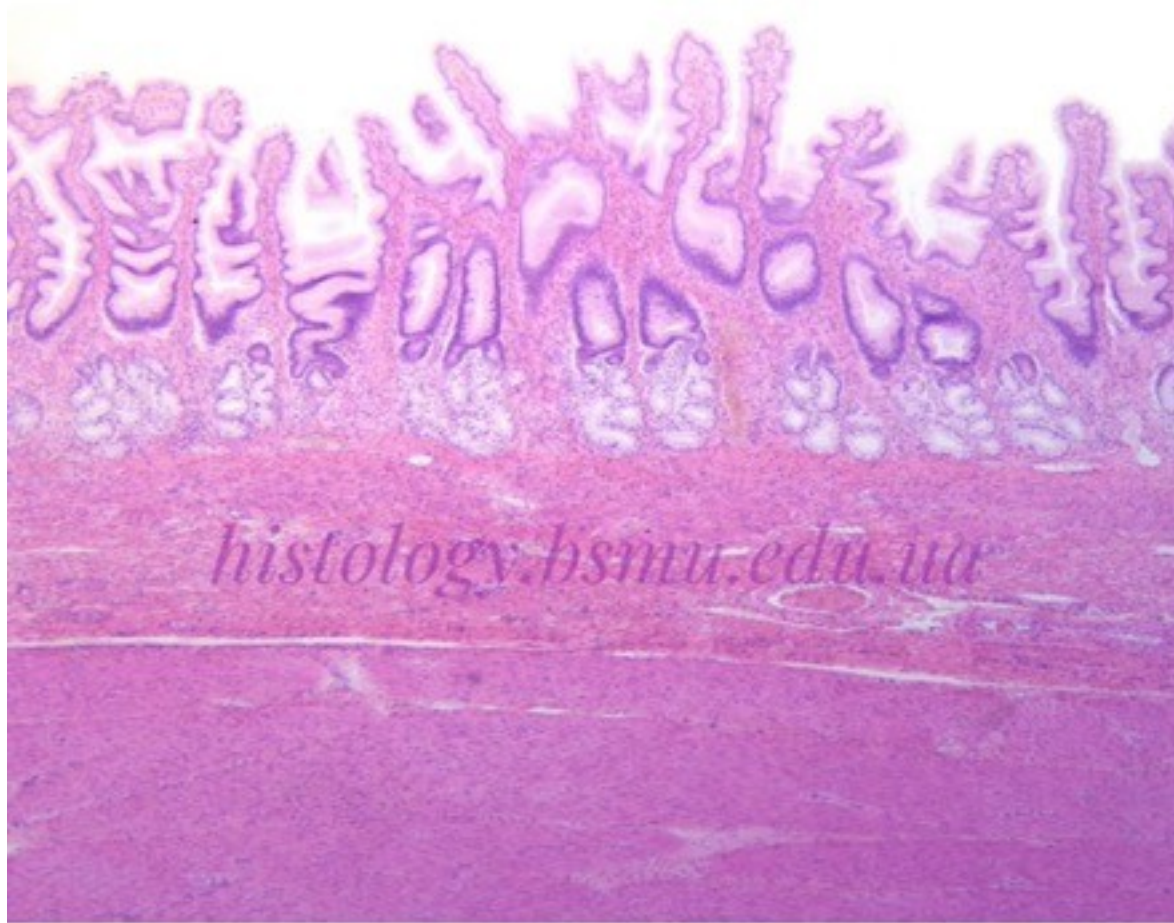
Coiled secretory

portions mostly cut in **T.S.** and **oblique** sections.

Pyloric glands are lined by:

- a) Mucous secreting cells
- b) Stem cells
- c) Enteroendocrine cells

Structure of Pylorus



Submucosa: smaller than in fundus

III- Muscularis: *No oblique layer*

- **Very thick inner circular** smooth m. forming the **pyloric sphincter.**

- Outer longitudinal smooth ms.
- ## IV- Serosa

Lecture quiz

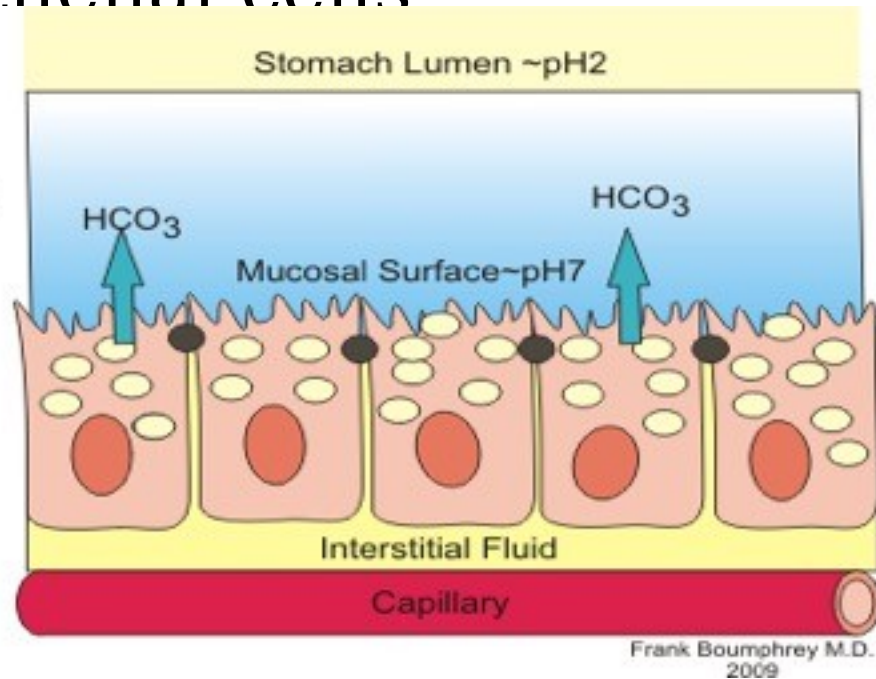


Compare between the histological structure of fundus & pylorus

	Fundus	Pylorus
Mucosa	Contain fundic glands: -simple branched tubular - numerous -perpendicular to surface - narrow lumina -narrow gastric pits -Gastric pits form $\frac{1}{4}$ of thickness of mucosa -lined by surface mucous cells, mucous neck cells, parietal cells, chief cells, stem cells, enteroendocrine cells	Contain pyloric glands: -simple branched tubular <u>coiled</u> -less numerous - not perpendicular to surface, secretory portions are cut in T.S. & oblique sections - wide lumina -<u>wide deep gastric pits</u> -Gastric pits form <u>1/2</u> the thickness of mucosa -lined by same cells but <u>no chief cells, nor mucous neck cells</u>)
Submucosa	c.t.	c.t.
Muscularis externa	3 layers: <u>inner oblique</u> , middle circular, outer longitudinal smooth	2 layers: - inner circular (greatly thickened forming pyloric sphincter)

Protective mechanism of gastric mucosa

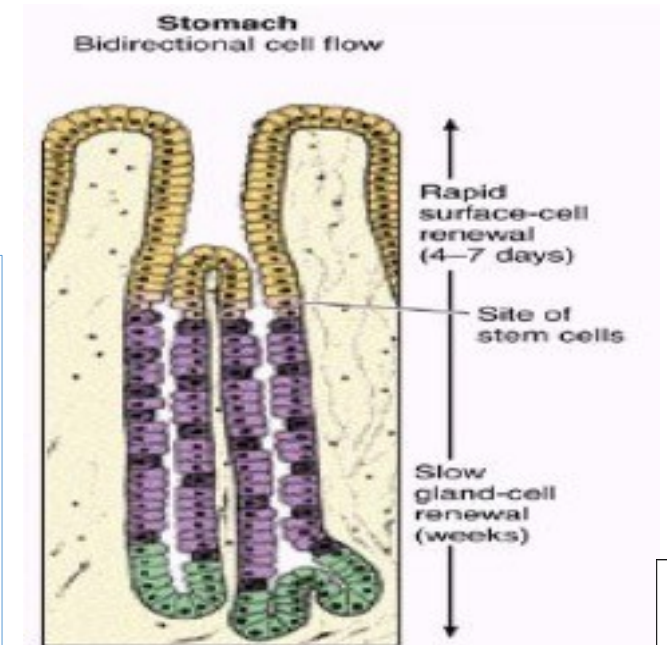
Thick coating of viscid mucus secreted by surface epithelial cells



teachmephysiology.com

Continuous Renewal of gastric mucosa
d.t. mitotic activity of stem cells in isthmus of fundic glands

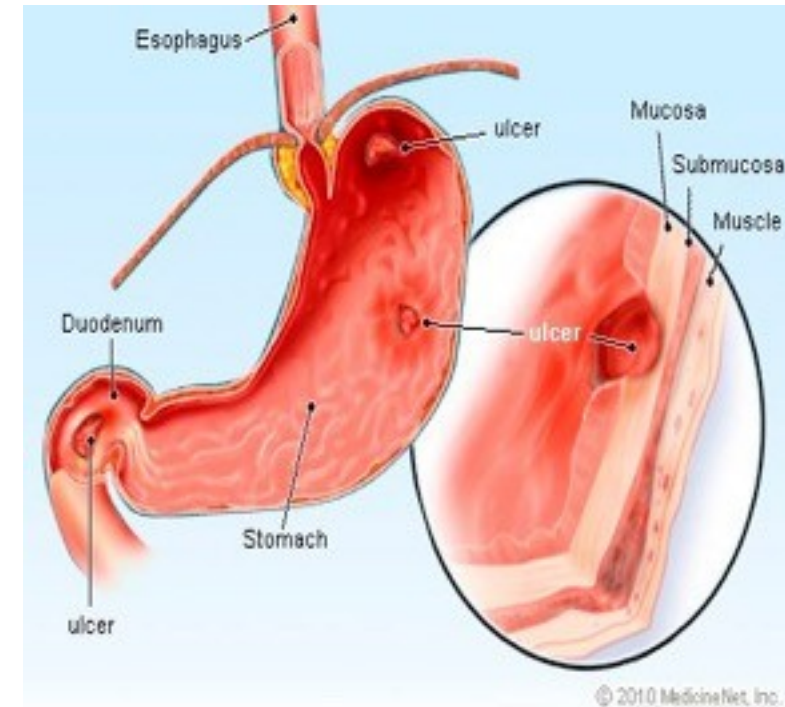
Renewal rate of epithelial lining is about 4-7 days



.amazonaws.com



- It is a painful erosive lesion of the **mucosa** that **may extend to deeper layers**.
- Such ulcers can occur anywhere between the lower esophagus and the jejunum



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- Causes:**
- Overproduction of HCl or pepsin.
 - Lowered production of mucus or bicarbonate.
 - Bacterial infections with *Helicobacter pylori*.
 - Effects of nonsteroidal anti-inflammatory drugs (NSAIDs).



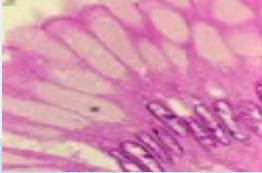
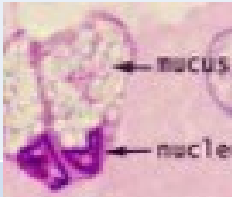
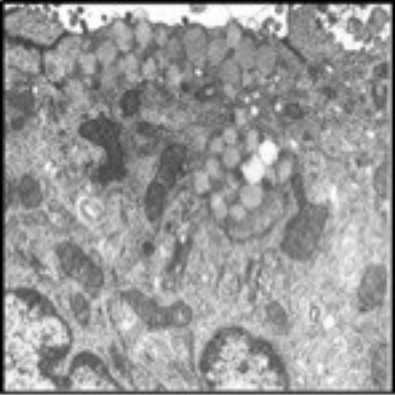
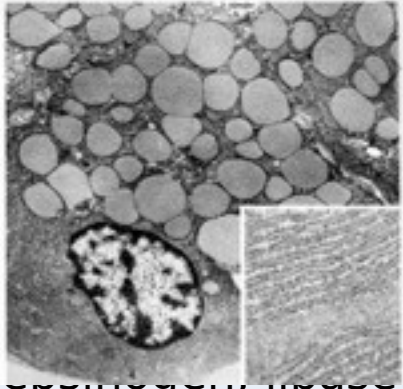
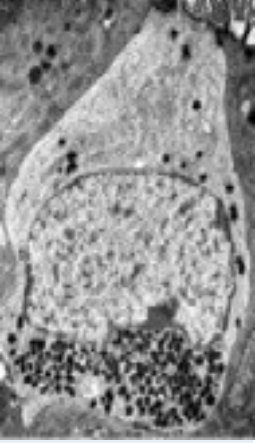
Key points off this lecture



1. Unique microscopic structure of the 4 layers of fundus and pylorus.
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Summary



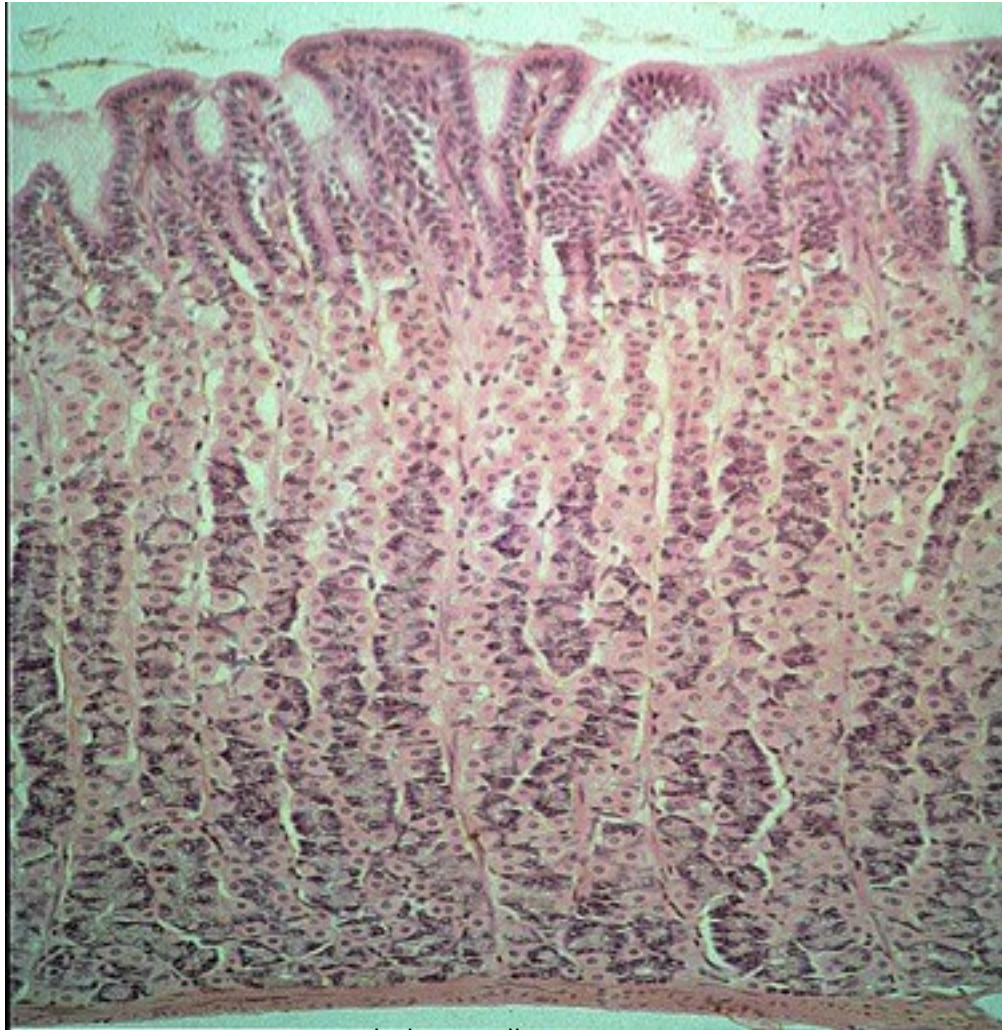
	Surface mucous secreting cell	Mucous neck cells	Chief cells	Enteroendocrine cells
Site	Surface, pit, isthmus	Neck	Base	scattered
LM	Basal basophilia, apical vacuolated cytoplasm 	Basal basophilia, apical vacuolated 	Basal basophilia, apical acidophilia 	Differentiated by immunohistochemistry 
EM	RER, Golgi, mitochondria 	RER, Golgi, mitochondria, many granules	Well developed RER, Golgi & mitochondria 	REI, Golgi, mitochondria Basal granules. 
Function	Viscid thick highly alkaline mucin	Soluble less alkaline mucin	Pepsinogen, lipase	Different hormones



Summary



Fundus



pathologyoutlines.com

Pylorus



Suggested textbooks



1- Junqueira`s Basic Histology; Text and Atlas. 14th edition 2018, pp: 307-314.

2- Histology atlas and test: Michael H. Ross and Wojciech Pawlina, 7th edition, 2015, pp: 572-581





**Thank
You**

Mahalo

Kiitos

Tack

Grazie

Toda

Obrigado

Takk

Thanks

Gracias

Merci

